PATENT ABSTRACTS OF JAPAN

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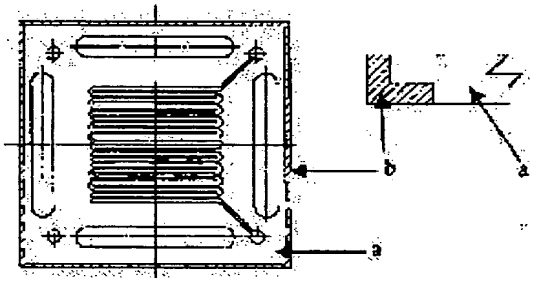
(54) FUEL CELL SEPARATOR MEMBER AND ITS MANUFACTURING METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a fuel cell separator that has solved a problem that it is easily broken when releasing a mold and the design of the shape of the groove and penetrating hole or the like is restricted when graphite material compound is used with resin as a binder in order to satisfy the electrical properties and corrosion resistance.
SOLUTION: This is a fuel cell separator member which has avoided the problem of breakage and warping or the like by enforcing the outer periphery of the fuel cell separator body a by a frame member b of a metal, resin, and wood or the like, without affecting the performance.



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CLAIMS

[Claim(s)]
[Claim 1] The fuel cell separator member characterized by having been fabricated with the ingredient containing graphite powder and strengthening a part of periphery or outside surface [at least] with reinforcing materials. [Claim 2] The separator member for fuel cells according to claim 1 characterized by reinforcing materials consisting of ingredients chosen from a metallic material, timber, resin, and a fiber consolidation resin ingredient.
[Claim 3] The separator member for fuel cells according to claim 1 to which reinforcing materials are characterized by consisting of ingredients of 30 or more MPas of flexural strength, and 3 or more GPas of bending elastics modulus.
[Claim 4] The separator member for fuel cells according to claim 1 whose reinforcing materials are frame material.
[Claim 5] The separator member for fuel cells according to claim 1 characterized by the ingredient containing graphite powder being an ingredient with which it was 30 or more MPas, and three or more 1.90 g/cm and flexural strength made graphite powder the amount five to 15 times to resin, kneaded and carried out shaping hardening of the blending ratio of coal of graphite powder and resin, and bulk density was obtained.
[Claim 6] The manufacture approach of the separator member for fuel cells characterized by really carrying out shaping hardening of the wrap reinforcing materials for graphite powder, the ingredient containing resin, the periphery of a separator member, or a part of outside surface [at least].

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the separator member for fuel cells.
[0002]
[Description of the Prior Art] The fuel cell used for an automobile loading application etc. attracts attention. This fuel cell is used as direct electrical energy, without transforming chemical energy into heat energy, and the cell which takes out the electrical and electric equipment by the reaction of hydrogen and oxygen is usually said. Although there is a thing of some methods, such as a phosphoric acid fuel cell, a solid oxide fuel cell, and a polymer electrolyte fuel cell (PEFC), in such a fuel cell, with the polymer electrolyte fuel cell and the phosphoric acid fuel cell, the separator which is conductive mold goods is used in it. While a separator constitutes a unit cell with an electrode etc., it is used for it, carrying out the laminating of this unit cell and isolates gas (hydrogen and oxygen), it needs the slot and breakthrough which pass gas in a laminating condition, and also it needs conductivity. Therefore, the electric high conductivity below 10x10-2ohmcm is required, and also gas permeability's being low, the hydrophilic property for draining effectively oxidation resistance, hydrolysis-proof nature, hot water resistance, and the generated water further, etc. are required. Moreover, in order to satisfy these properties, the metal of corrosion resistance [ingredient / separator], the compound of a graphite ingredient, a graphite ingredient, and resin, etc. are used.
[0003] In JP,8-31231,A, in order that voidage may obtain the carbon material for which the value of the ratio of the volume resistivity of the XY direction of a Plastic solid and the volume resistivity of a Z direction was suitable as two or less separator for fuel cells 5% or less, the carbon material which blended the thermosetting resin, KETCHIEN black, and real ball-like graphite particle is proposed. Moreover, in JP,11-195422,A, in order to reduce the amount of a binder and to raise conductivity, the approach of blending and carrying out pressing of the little binder to a carbon ingredient, and carrying out impregnation of the impregnant after that is proposed. Furthermore, in JP,11-297338,A, in order that contact resistance with the polar zone may obtain the low separator for fuel cells, the separator for fuel cells which made surface roughness the fixed range is proposed. Moreover, in JP,2000-40517,A, in order to obtain the separator member for fuel cells with little anisotropy, it has proposed using an artificial graphite and a natural graphite together. In JP,2000-21421,A, in order to obtain the separator member for fuel cells which maintained balance gas impermeable, thermally conductive, conductive, it has proposed using the specific end of graphite complications.
[0004] As the manufacture approach of these separator members, larger mold goods are once made, and it is divided roughly into the approach of processing [recessing] it, and the approach of carrying out recessing simultaneously at the time of shaping. When once making larger mold goods and carrying out recessing of it, although it can respond to a complicated configuration, the fabrication of a separator takes time amount, and fabrication costs are also expensive and it is not suitable for industrial mass production. Moreover, troubles, like combination of a graphite ingredient can divide overwhelmingly the approach of carrying out recessing simultaneously at the time of molding processing into shaping mold release very easily in many separator

ingredients from binder resin occur, and the design of the shape of a quirk of a separator, a through hole, etc. is restrained.
[0005] The example which constitutes the construction material of a separator from a pure copper, stainless steel, etc. is indicated by JP,4-267062,A. In order to contact [a deer, however the hydrogen gas and the long duration which are used as fuel gas with the construction material of these metal systems], there is a fault to which hydrogen embrittlement arises, construction material degradation takes place, and the cell engine performance falls, and processing of gold plate etc. is required to carry out a rear-spring-supporter activity, and it becomes a cost rise at a long period of time. Furthermore, it has proposed making both sides of a metallic thin plate put the hardening resin Plastic solid of the thermosetting resin which carbonaceous powder distributed on a JP,11-297337,A official report. By this approach, although degradation of a metallic material can be prevented, a problem is in scaling coat clearance of the interface of a metallic thin plate and a hardening resin Plastic solid.
[0006]
[Problem(s) to be Solved by the Invention] The object of this invention offers the fuel cell separator with which were satisfied of the property required of fuel cell separators, such as electric conductivity and oxidation resistance, by the comparatively easy and economical approach in view of this actual condition. Other objects offer the fuel cell separator which can respond to a complicated configuration. Furthermore, other objects are offering the approach of processing a predetermined configuration, without causing a crack etc. even if it is weak ingredients, such as carbon material, and processes a complicated configuration.
[0007]
[Means for Solving the Problem] this invention person etc. came to complete a header and this invention for the approach of processing a predetermined configuration, without causing a crack etc. even if it is weak ingredients, such as carbon material, and processes a complicated configuration, by reinforcing a part of outside surfaces, such as a periphery of a fuel cell separator, with reinforcing materials, such as frame material, as a result of inquiring wholeheartedly, in order to attain the above-mentioned object. [0008] That is, this invention is the fuel cell separator member which was fabricated with the ingredient containing graphite powder and strengthened a part of outside surfaces [at least], such as a periphery, with reinforcing materials. It is advantageous to consist of ingredients of to consist of ingredients chosen from a metallic material, timber, resin, and a fiber consolidation resin ingredient as reinforcing materials here or 30 or more MPas of flexural strength, and 3 or more GPas of bending elastics modulus. Moreover, this invention is said separator member for fuel cells whose reinforcing materials are frame material. Furthermore, the ingredient with which this invention contains graphite powder is the aforementioned separator member for fuel cells whose bulk density is the ingredient obtained by three or more 1.90 g/cm and flexural strength being 30 or more MPas, making graphite powder an amount for the blending ratio of coal of graphite powder and resin five to 15 times to resin, and kneading and carrying out shaping hardening. Moreover, this invention is the manufacture approach of the separator member for fuel cells which really carries out shaping hardening of the wrap reinforcing materials for a part of outside surfaces [at least], such as graphite powder, an ingredient containing resin, and a periphery of a separator member.
[0009] This invention is explained below at a detail. The separator for fuel cells is formed between the adjoining unit cells in the fuel cell which carries out two or more laminatings of the unit cell, and constitutes it, fuel gas passage and an oxidation gas passageway are formed between electrodes, it has the operation which separates fuel gas and oxidation gas, and a slot, a breakthrough, etc. for gas passagewaies are formed. The separator for fuel cells of this invention serves as a member used as all of these separators for fuel cells, or the body. The separator for fuel cells of this invention consists of a bonnet and reinforcing materials who strengthen in the part which the tabular body fabricated with the ingredient containing graphite powder, and the periphery or an outside surface tends to damage.
[0010] Resin, such as for example, graphite complications, thermoplastics, and heat-curing resin, and after mixing heat-curing resin at a rate of 5-15:1 by the weight ratio and grinding this

preferably, the body fabricated with the ingredient containing graphite powder can be hardened after press forming which inserted the frame material made from SUS etc., and can be manufactured. If the ratio of graphite complications and resin, such as heat-curing resin, is larger than 15, a consistency will not fully go up but the impermeability of gas will fall. Moreover, if this is smaller than 5, conductivity will fall and sheet resistivity will not fully fall. Although there will be no limit if the graphite powder to be used shows high conductivity, for example, a special carbon material like what graphitized the carbonaceous of a meso carbon micro bead etc., the thing which graphitized coal system corks and petroleum system corks, a graphite electrode, or an isotropic graphite, a natural graphite, kish graphite, etc. are used, and also the processing powder of a graphite electrode etc. is used.

[0011] using the graphite powder which has at least two kinds of particle size distributions, in order to raise bulk density -- desirable -- the mean particle diameter of 50-300 micrometers -- desirable -- the graphite powder A with a mean particle diameter of 80-150 micrometers and the mean particle diameter of less than 50 micrometers -- desirable -- the graphite powder B with a mean particle diameter of 1-20 micrometers -- using it -- the rate of the graphite powder A and the graphite powder B -- a weight ratio -- 60:40-90:10 -- it is the range of 70:30-80:20 preferably. Furthermore, in order to raise bulk density, it is also effective to choose the class of graphite powder and the combination of isotropic graphite complications and kish graphite is excellent. In this case, it is good to use isotropic graphite complications as the graphite powder A of said mean particle diameter, and to use kish graphite as the graphite powder B of said mean particle diameter. Isotropic graphite complications graphitize, grind and use the mold goods obtained by fabricating operations, such as well-known CIP shaping.

[0012] In this invention, although the resin used with a graphite has desirable thermosetting resin, it is thermal resistance, and if it is resin which is hypoviscosity, even if it is thermoplastics and thermosetting resin, there is especially no limit in extent which can be kneaded, for example, it can use resin, such as phenol resin, furfuryl alcohol resin, an epoxy resin, a urea-resin, and melamine resin, for it. Preferably, it is an epoxy resin and this is used with polyhydric-phenol system curing agents, such as novolak resin. In addition, although thermosetting resin may use a curing agent, a hardening accelerator, etc., since these react with thermosetting resin and become some resin in many cases when it hardens, these are also calculated as resin in principle.

[0013] Moreover, a curing agent, the hardening accelerator and the additive for refining, other conductive fillers, etc. which were mentioned above can also be blended besides resin, such as graphite powder and thermosetting resin, in the range which does not bar the effectiveness of this invention. As an additive for refining, fine-particles-like release agents, such as liquids, such as a liquid paraffin, or carnauba wax, low-molecular-weight polyethylene wax, and zinc stearate, an antioxidant, a plasticizer, and other various additives are mentioned. Moreover, the additive with which the hydrophilic property of a surfactant, hydrophilic resin, etc. is assisted may be used together in the range which does not bar the effectiveness of this invention. Thermoplastics, such as a polyamide, polyethylene, polypropylene, polybutylene terephthalate (PBT), and a liquid crystal polymer (LCP), may be used for the resin furthermore used.

[0014] As for the constituent which blended thermosetting resin with graphite complications, grinding, after mixing by kneading etc. is desirable, and 50 micrometers or less of things set to 20-40 micrometers of the mean particle diameter of a grinding object are preferably advantageous. When the electric specific resistance of a Plastic solid does not fully fall that it is 50 micrometers or more and particle size is made small too much, grinding costs not only increase, but the inclination for electric specific resistance to become high is in reverse.

[0015] Although there is no limit according to rank in the method of fabricating the compound of graphite complications and thermosetting resin, the various press-forming methods or the injection-molding method which uses metal mold is advantageous. For example, it fabricates using a compacting machine, an injection molding machine, etc. of heating and an application-of-pressure mold by metal mold. Under the present circumstances, in order to harden thermosetting resin to shaping and coincidence, it is good to perform 100-350 degrees C by holding at about 150-200 degrees C preferably. Temperature is made into the conditions of under carbonization

temperature more than the curing temperature of the thermosetting resin to be used. Since facility costs will increase if a pressure is made high, 200 - 600 kg/cm2 is still more preferably suitable [in order to make lowering and bulk density high for the electric specific resistance of the direction of a field, the higher one of compacting pressure is desirable, but] about two 100 - 800 kg/cm preferably about two 20 - 1000 kg/cm.

[0016] As for the body of the separator member for fuel cells of this invention, it is desirable that the sheet resistivity (planar pressure 0.5MPa) in which it was good for that bulk density was three or more 1.95 g/cm preferably three or more 1.90 g/cm, and it contained carbon paper from the point of gas impermeability or a mechanical strength is two or less 40momegacm. In addition, sheet resistivity shall follow the measuring method indicated in the example which carries out a postscript. Furthermore, it is desirable for flexural strength to have 30 or more MPas, and for gas permeability to have two or less 1x10 to 14 cm any 1 or two or more properties.

[0017] Reinforcing materials (both are hereafter called frame material etc. collectively), such as frame material for a consolidation, are attached in a part of outside-surface sections [at least], such as the periphery section of a body, and let the separator member for fuel cells of this invention be the separator member for fuel cells of this invention. Although methods of cling, such as frame material to a body, have a method of fabricating a body and attaching frame material etc. in this after drawing etc., from the object which prevents the crack at the time of mold release and processing, the approach by the manufacture approach of this invention is advantageous. They are the manufacture approach of this invention, graphite powder, an ingredient containing resin, and the approach of hardening heat-curing resin, while really fabricating a part of outside surface [at least] of a separator member for wrap frame material etc. the slot and breakthrough which the separator member for fuel cells which is fabricated as mentioned above and manufactured is usually a plate, and pass gas etc. -- the time of shaping -- or it is prepared in a predetermined number and a predetermined location as occasion demands at the time of processing after shaping.

[0018]

[Embodiment of the Invention] Hereafter, this invention is explained with reference to the drawing in which the example is shown. Drawing 1 is the top view showing the outline of the separator member for fuel cells of this invention, and drawing on the right-hand side of drawing 1 is an expanded sectional view of the frame material b arrangement section. The frame material b is attached and strengthened by the periphery of the body a of a separator made into the predetermined configuration. Since the frame material b is arranged only in the rim section which is not related to a gas passageway, a fuel cell separator can be strengthened without affecting a corrosion problem and an electrical property at all, and it has the camber prevention effectiveness of the separator for fuel cells further. Moreover, it is not necessary to attach the frame material b in all of the periphery sections of a body, and it may be attached only in the part which is [corner] easy to suffer a loss.

[0019] Although construction material, such as frame material, is not especially restrained if it is also being able to reinforce a fuel cell separator, reinforcement and its rigidity are high and it is desirable. [of the ingredient with which reinforcement and an elastic modulus do not fall to the bottom of molding temperature or an operating environment] From a viewpoint which prevents a crack, 30 or more MPas of tensile strength are 50 or more MPas more preferably desirably. From a viewpoint which raises rigidity, is hard to transform, carries out, and prevents a crack, 3 or more GPas of bending elastics modulus are 5 or more GPas more preferably desirably. Moreover, the ingredient which has corrosion resistance collectively is desirable.

[0020] Metallic materials and timber, such as SUS, plating sheet metal, copper, and titanium, can be used for construction material, such as frame material from this viewpoint, and also the resin ingredient strengthened with fillers, such as resin and a glass fiber, carbon fiber, and a ceramic, can be used for it. For example, the resin ingredient which strengthened the resin ingredient corresponding to molding temperature with a filler, especially fiber is desirable. When the productivity of frame material is especially taken into consideration, the construction material of a metallic material, timber, fiber consolidation resin, etc., etc. is desirable. Moreover, you may use it combining these ingredients. Some examples usable as construction material, such as frame

material, are shown in a table 1. In a table 1, reference GF30% has thermal resistance as low as less than 180 degrees C, and although it is the example which may produce constraint in molding temperature or service temperature, when molding temperature or service temperature is low, it is usable.

[0021]

[A table 1]

繊維強化有無	樹脂名称	連続使用温度 ℃	引張強度 MPa	曲げ弾性率 GPa
なし	PTFE	260	34	-
	PEEK	230	91	3.9
	PAI	240	186	4.4
	PI	250	69	2.4
GF30%	LCP	250	157	12
	PEEK	230	173	10
	PEN	220	193	11
	PPS	200	151	10
参考 GF30%	PA66	100	177	8
	PBT	120	128	10
	PET	130	118	10
鉄		-	412	21
木材		-	曲げ54	7.8

[0022] Configurations, such as frame material used by this invention, can also be band forms arranged only on the thing of the configuration of the cross-section the mold of L characters which protects not only the character type configuration of cross-section KO of a configuration but the base or front face which it is not especially limited and carries out checking and verifying to the periphery section of a body, and a side face, and the side face of the body periphery section, if a fuel cell separator member can be reinforced. Furthermore, it is good also considering a cross section as a configuration of others, such as a triangle and a trapezoid, and beveling processing of an edge may be done R ****s.

[0023] It combines with the attaching structure of the frame material to a body 1, and the configuration of frame material is shown in drawing 2 . In drawing 2 , the slash section expressed with b1-b6 shows frame material, and the part which is not the slash section shows the body. The frame material of the mode of b1 shows the flat-surface molding flask material arranged only on the base of a body. The frame material of the mode of b2 shows the flat-surface molding flask material arranged only to the vertical plane which is a side face of a body. The frame material of the mode of b3 shows the triangle frame material arranged to the vertical plane which is the part and side face of a body at the bottom. The frame material of the mode of b4 shows the L form frame material arranged to the vertical plane which is the part and side face of a body at the bottom. The frame material of the mode of b5 shows the flat-surface molding flask material arranged to a part of vertical plane which is a side face of a body. The frame material of the mode of b6 shows the KO typeface frame material arranged to the vertical plane which is the base, front face, and side face of a body.

[0024] Frame material etc. has some which are arranged to two parallel sides made to adjoin each other two sides and three sides of arbitration only one side, when arranging only in what has been arranged to all four sides when for example, a fuel cell separator is a square, and the part which has a problem in reinforcement. Moreover, it is also good to change configurations, such as frame material, according to the design of a slot or a hole. A breakthrough is formed, the part which became thin thickness is mentioned, and the part which there is a problem in reinforcement and is easy to produce a crack can station frame material or reinforcing materials also to the circumference of a breakthrough, and the outside surface of the part which became thin thickness. Moreover, also in polygons other than a square, or a circle and an ellipse, a fuel cell separator member should just arrange in the location of the arbitration corresponding to this.

[0025] In order to strengthen adhesion of the body of a fuel cell separator, frame material, etc., ** which prepares the breakthrough or the hole which is not penetrated which attaches

unevenness, and to damage in front faces, such as frame material, is effective. Drawing 3 is the mode **** explanatory view, and is a cross-section explanatory view in the part which the slash section showed frame material, and the part which is not the slash section showed the body, and prepared some breakthroughs in frame material. f1 of drawing 3 is an example which shows the mode which prepared the breakthrough in a part of rim base of a body at the flat-surface molding flask material which has arranged frame material. f2 is an example which shows the mode which prepared the breakthrough only in the vertical plane which is a peripheral surface at the flat-surface molding flask material which has arranged frame material. f3 is an example which shows the mode which prepared the breakthrough in the triangle frame material arranged to the vertical plane which is the part and peripheral surface at the base of a rim of a body. f4 is an example which shows the mode which prepared the breakthrough in L printing form material arranged to the vertical plane which is the part and peripheral surface at the base of a rim of a body. f5 is an example which shows the mode which prepared the breakthrough in the flat-surface molding flask material arranged to a part of vertical plane which is a peripheral surface of a body. f6 is an example which shows the mode which prepared the breakthrough in the KO typeface frame material arranged on a part of vertical plane which is a peripheral surface of a body, base, and front face. And a body formation ingredient enters into said breakthrough, and unification reinforcement is raised to it. Furthermore, if R and beveling processing are performed for the end face of said breakthrough, the blank prevention effectiveness of frame material increases and is advantageous.

[0026] When breaking the above holes, especially as for the configuration of the hole, a circle, a square, a rectangle, other polygons, an ellipse, a slot, a star type, etc. do not receive constraint. Especially constraint is not received that what is necessary is just to design the magnitude of a hole, and arrangement and a number according to the dimension and hole configuration of a fuel cell separator or frame material. Moreover, you may carry out combining these damaging [which attaches unevenness to the front face of frame material], preparing a breakthrough or a non-breakthrough in frame material, etc. When using the frame material of a KO typeface, it is desirable to prepare a breakthrough in a top face. What is necessary is just to take approaches which especially constraint does not have and were suitable for the ingredient, such as machining, molding processing, and the chemical approach, since the approach of attaching unevenness to the front face of frame material and the method of breaking the approach hole to damage have a proper approach in a metal, resin, timber, etc.

[0027] It is good, and arranging frame material etc. only in the periphery section which is not related to a gas passageway, or the rim section can strengthen a fuel cell separator, without affecting a corrosion problem and an electrical property at all in that case, and it also has the camber prevention effectiveness of the separator for fuel cells further.

[0028]

[Example] Although a concrete example is given to below and this invention is further explained to a detail, this invention is not limited to these examples at all. The assessment approach of the separator member in an example etc. is as follows.

[0029] (1) It fabricated using the fuel cell separator separator metal mold shown in reinforcement effectiveness drawing 4 by frame material, and effectiveness was judged by the crack existence at the time of mold release. Drawing 4 R> 4 is the top view of the fuel cell separator metal mold of the configuration which a crack tends to generate at the time of mold release, c1, c2, c3, and c4 are heights which form a penetration long hole, d1, d2, d3, and d4 are heights which form a penetration stoma, and e is a height which forms the Serpentine slot.

[0030] (2) Sheet resistivity (momegacm2)

a conceptual diagram for drawing 5 to explain the measuring method of sheet resistivity -- it is -- the sample (separator member) 1 with a thickness of 3mm -- up and down -- carbon paper 2 -- arranging -- further -- the -- a copper plate 3 is arranged up and down, and the pressure of planar pressure 0.5MPa is put in the vertical direction. Resistance (average) is calculated by reading the current between the copper plates 3 of two sheets with an ammeter 5 at the same time it reads the electrical potential difference between the carbon paper 2 of two sheets with a voltmeter 4. In addition, the used carbon paper is the TGP-H-M series (090M : 0.38mm in

0.28mm in thickness, 120M:thickness) by Toray Industries, Inc.
(3) The camber measurement this fuel cell separator was placed on the surface plate, the distance from a laser displacement gage to each point of measurement (17 places) of a fuel cell separator was measured with the laser displacement gage from the top face, the difference of the maximum of distance and the minimum value was computed, and measurement made into the amount of camber was performed.
[0031] The thermosetting resin it is incomparable in a total of 100 graphite powder weight sections which mixed the isotropic artificial-graphite powder 50 weight section and the kish graphite powder 50 weight section with a mean particle diameter of 10 micrometers which were obtained with CIP shaping with example 1 mean particle diameter of 110 micrometers from an epoxy resin, a curing agent, and a hardening accelerator was blended by graphite powder volume / amount =of thermosetting resin 9 (weight ratio). Here, thermosetting resin is blended as the tetramethyl bisphenol female mold epoxy resin (Nippon Steel Chemical Co., Ltd. make, trade name YSLV-80XY) 2 weight section and a curing agent, and it blends it as an epoxy resin at a rate of the triphenyl phosphine (Hokko Chemical Industry Co., Ltd. make) 0.03 weight section as the phenol novolak (TAMANORU 758 by Arakawa chemical-industry company) 1 weight section, and a hardening accelerator. This was kneaded with the roll heated at 100 degrees C. The obtained kneading object was pulverized with the grinder. The with a width-of-face height [1.9mm height of 2mm] frame material made from SUS was inserted to the metal mold inner circle wall, said grinding object was put into said metal mold of 120x120x1.9mm size, and it fabricated on the temperature of 175 degrees C, and conditions with a pressure of 350kg/cm2 for 20 minutes, and it considered as the mold goods of the structure of having frame material in the perimeter of a periphery side face, and released from mold. The crack situation and physical-properties value of mold goods which were acquired are shown in a table 2.
[0032] In the same experiment as example 2 example 1, it fabricated by the same approach as an example 1 except having used the frame material made from timber as frame material. The crack situation and physical-properties value of mold goods which were acquired are shown in a table 2.
[0033] In the same experiment as example of comparison 1 example 1, it fabricated by the same approach as an example 1 except having not used frame material. The crack situation and physical-properties value of mold goods which were acquired are shown in a table 2. In the examples 1 and 2, although a crack was not produced, in the example 1 of a comparison which has not attached frame material, the crack has been produced to the part which became thin near the breakthrough formed as a drain hole. Moreover, the amount of camber also became more than twice compared with the example.
[0034]
[A table 2]

項目	実施例１	実施例２	比較例１
割れ状況	割れなし	割れなし	割れ発生
面積抵抗 mΩcm²	１５．１	１５．２	１５
そり量 μm	４０	５０	１２０

[0035]
[Effect of the Invention] Since problems, such as a crack and camber, can be avoided by strengthening with frame material parts which are easy to damage, such as the periphery section of a fuel cell separator, according to this invention, without affecting the engine performance, constraint decreases in the design of a separator configuration, it can contribute to the engine-performance rise of a fuel cell, and the value as a separator for fuel cells is high.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The outline diagram of a fuel cell separator
[Drawing 2] The sectional view of the ****** circumference
[Drawing 3] Other sectional views of the ****** circumference
[Drawing 4] The top view of fuel cell separator metal mold
[Drawing 5] The conceptual diagram for explaining the measuring method of sheet resistivity
[Description of Notations]
a: The body of a fuel cell separator
b: Frame material

[Translation done.]

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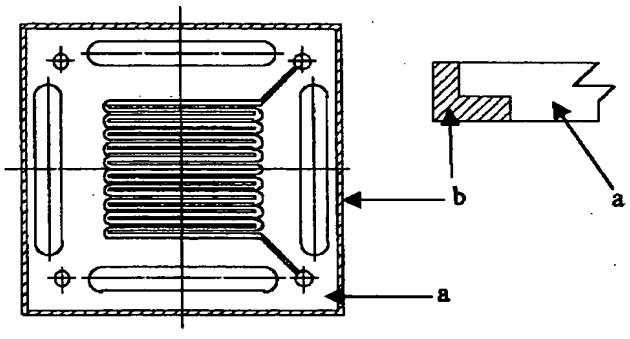
(54)【発明の名称】　燃料電池セパレータ部材及びその製造方法

(57)【要約】
【課題】　電気特性や耐腐食性を満足するために樹脂をバインダーとした黒鉛材料コンパウンドを用いる場合、成形離型時に割れやすく、溝形状や貫通穴等の設計が制約されることを解決した燃料電池セパレータを提供する。
【解決手段】　燃料電池用セパレータ本体aの外周部を金属、樹脂、木材等の枠材bで補強することで、性能に影響を及ぼさずに、割れやそり等の問題を回避した燃料電池セパレータ部材。



【特許請求の範囲】

【請求項１】　黒鉛粉を含有する材料で成形され、外周又は外表面の少なくとも一部を補強材で強化したことを特徴とする燃料電池セパレータ部材。

【請求項２】　補強材が、金属材料、木材、樹脂及び繊維強化樹脂材料から選択される材料で構成されていることを特徴とする請求項１記載の燃料電池用セパレータ部材。

【請求項３】　補強材が、曲げ強度３０MPa以上、曲げ弾性率３GPa以上の材料で構成されていることを特徴とする請求項１記載の燃料電池用セパレータ部材。

【請求項４】　補強材が、枠材である請求項１記載の燃料電池用セパレータ部材。

【請求項５】　黒鉛粉を含有する材料が、嵩密度が１．９０g/cm^{3}以上、曲げ強度が３０MPa以上であって、黒鉛粉と樹脂との配合割合を、樹脂に対し黒鉛粉を５～１５倍量とし、混練、成形硬化して得られた材料であることを特徴とする請求項１記載の燃料電池用セパレータ部材。

【請求項６】　黒鉛粉と樹脂を含有する材料と、セパレータ部材の外周又は外表面の少なくとも一部を覆う補強材とを、一体成形硬化することを特徴とする燃料電池用セパレータ部材の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、燃料電池用のセパレータ部材に関するものである。

【０００２】

【従来の技術】自動車搭載用途等に利用される燃料電池が注目されている。この燃料電池は、化学エネルギーを熱エネルギーに変換することなく直接電気エネルギーとして利用するものであり、通常、水素及び酸素の反応によって電気を取出す電池をいう。こうした燃料電池には、リン酸型燃料電池、固体電解質型燃料電池及び固体高分子型燃料電池（ＰＥＦＣ）等いくつかの方式のものがあるが、その中で固体高分子型燃料電池、リン酸型燃料電池では導電性成形品であるセパレータが使用されている。セパレータは、電極等と共に単位セルを構成し、該単位セルを積層して使用されるものであって、ガス（水素・酸素）を隔離する一方で、ガスを積層状態において流す溝と貫通孔を必要とする他、導電性を必要とする。そのため、１０×１０$^{-2}$Ωｃｍ以下の高い電気導電性が要求される他、気体透過率が低いこと、更には耐酸化性、耐加水分解性、耐熱水性、生成した水を効果的に排水するための親水性などが要求される。また、これらの特性を満足するために、セパレータ材料は耐食性の金属や、黒鉛材料、黒鉛材料と樹脂のコンパウンド等が用いられている。

【０００３】特開平８－３１２３１号公報では、空隙率が５％以下、成形体のXY方向の体積固有抵抗とZ方向の体積固有抵抗の比の値が２以下の燃料電池用セパレータとして適した炭素材を得るため、熱硬化性樹脂とケッチェンブラック、真球状黒鉛粒子を配合した炭素材を提案している。また、特開平１１－１９５４２２号公報では、バインダーの量を減らして、導電性を向上させるため、カーボン材料に少量のバインダーを配合して加圧成形し、その後含浸剤を含浸させる方法が提案されている。更に、特開平１１－２９７３３８号公報では、電極部との接触抵抗が低い燃料電池用セパレータを得るため、表面粗さを一定範囲とした燃料電池用セパレータを提案している。また、特開平２０００－４０５１７号公報では、異方性の少ない燃料電池用セパレータ部材を得るため、人造黒鉛と天然黒鉛を併用することを提案している。特開平２０００－２１４２１号公報では、ガス不透過性、熱伝導性、導電性等のバランスがとれた燃料電池用セパレータ部材を得るため、特定の黒鉛紛末を使用することを提案している。

【０００４】これらのセパレータ部材の製造方法としては、一旦大きめの成形品を作り、それを溝加工等の加工する方法や、成形時に同時に溝加工する方法に大別される。一旦大きめの成形品を作りそれを溝加工する場合は、複雑な形状に対応出来るがセパレータの製作に時間がかかり、製作費用も高価であり、工業的量産には適さない。また、成型加工時に同時に溝加工する方法は、バインダー樹脂より黒鉛材料の配合が圧倒的に多いセパレータ材料においては、非常に脆く成形離型に割れる等のトラブルが発生し、セパレータの溝形状や貫通穴等の設計が制約される。

【０００５】特開平４－２６７０６２号公報にはセパレータの材質を純銅やステンレス鋼などで構成する例が開示されている。しかしかしながら、これらの金属系の材質では燃料ガスとして用いる水素ガスと長時間に亘って接触するために、水素脆性が生じて材質劣化が起こり電池性能が低下する欠点があり、長期にわたり使用するには金メッキ等の処理が必要でありコストアップとなる。更に、特開平１１－２９７３３７公報には、金属薄板の両面に炭素質粉末が分散した熱硬化性樹脂の硬化樹脂成形体を被着させることを提案している。この方法では、金属材料の劣化は防止可能であるが、金属薄板と硬化樹脂成形体の界面の表面酸化皮膜除去に問題がある。

【０００６】

【発明が解決しようとする課題】本発明の目的は、かかる現状に鑑み、比較的容易で、経済的な方法で電気導電性や耐酸化性等の燃料電池セパレータに要求される特性を満足した燃料電池セパレータを提供するものである。他の目的は、複雑な形状に対応可能な燃料電池セパレータを提供するものである。更に他の目的は、炭素材等の脆い材料であっても複雑な形状に加工しても割れ等を起こさずに所定の形状に加工する方法を提供することである。

【０００７】
【課題を解決するための手段】本発明者等は、上記目的を達成するために鋭意検討した結果、燃料電池セパレータの外周等の外表面の一部を枠材等の補強材で補強することにより、炭素材等の脆い材料であっても複雑な形状に加工しても割れ等を起こさずに所定の形状に加工する方法を見出し、本発明を完成するに至った。
【０００８】すなわち本発明は、黒鉛粉を含有する材料で成形され、外周等の外表面の少なくとも一部を補強材で強化した燃料電池セパレータ部材である。ここで、補強材としては、金属材料、木材、樹脂及び繊維強化樹脂材料から選択される材料で構成されていること、又は曲げ強度３０MPa以上、曲げ弾性率３GPa以上の材料で構成されていることが有利である。また、本発明は、補強材が枠材である前記燃料電池用セパレータ部材である。更に、本発明は、黒鉛粉を含有する材料が、嵩密度が１．９０g/cm^{3}以上、曲げ強度が３０MPa以上であって、黒鉛粉と樹脂との配合割合を、樹脂に対し黒鉛粉を５～１５倍量とし、混練、成形硬化して得られた材料である前記の燃料電池用セパレータ部材である。また、本発明は、黒鉛粉と樹脂を含有する材料と、セパレータ部材の外周等の外表面の少なくとも一部を覆う補強材とを、一体成形硬化する燃料電池用セパレータ部材の製造方法である。
【０００９】以下に本発明を詳細に説明する。燃料電池用セパレータは、単位セルを複数積層して構成する燃料電池において、隣接する単位セル間に設けられ、電極との間で燃料ガス流路、酸化ガス流路を形成し、燃料ガスと酸化ガスとを隔てる作用を有するものであり、ガス流路用の溝及び貫通孔等が形成されている。本発明の燃料電池用セパレータは、この燃料電池用セパレータの全部又は主要部となる部材となるものである。本発明の燃料電池用セパレータは、黒鉛粉を含有する材料で成形された板状の本体と、その外周又は外表面の損傷しやすい部位を覆い、強化する補強材とから構成されている。
【００１０】黒鉛粉を含有する材料で成形された本体は、例えば、黒鉛紛と熱可塑性樹脂、熱硬化樹脂等の樹脂、好ましくは熱硬化樹脂とを、重量比で５～１５：１の割合で混合し、これを粉砕したのち、SUS製の枠材等をインサートしたプレス成形後、硬化して製造することができる。黒鉛紛と熱硬化樹脂等の樹脂との比が１５より大きいと、密度が十分に上がらず、ガスの不透過性が低下する。また、これが５より小さいと、導電性が低下し、面積抵抗が十分に下がらない。使用する黒鉛粉は高い導電性を示すものであれば制限はないが、例えば、メソカーボンマイクロビーズなどの炭素質を黒鉛化したもの、石炭系コークスや石油系コークスを黒鉛化したもの、黒鉛電極や等方性黒鉛のような特殊炭素材料、天然黒鉛やキッシュ黒鉛等が使用される他、黒鉛電極の加工粉等も使用される。
【００１１】嵩密度を上げるためには、少なくとも２種類の粒度分布を有する黒鉛粉を使用することが好ましく、平均粒径５０～３００μm、好ましくは平均粒径８０～１５０μmの黒鉛粉Aと平均粒径５０μm未満、好ましくは平均粒径１～２０μmの黒鉛粉Bを使用し、黒鉛粉Aと黒鉛粉Bの割合は、重量比で６０：４０～９０：１０、好ましくは７０：３０～８０：２０の範囲である。更に、嵩密度を上げるためには、黒鉛粉の種類を選択することも有効であり、等方性黒鉛紛とキッシュ黒鉛の組合せが優れる。この場合、等方性黒鉛紛を前記平均粒径の黒鉛粉Aとし、キッシュ黒鉛を前記平均粒径の黒鉛粉Bとすることがよい。等方性黒鉛紛は、公知のＣＩＰ成形等の成形加工により得られる成形品を黒鉛化し、粉砕して使用する。
【００１２】本発明において、黒鉛と共に使用する樹脂は、熱硬化性樹脂が好ましいが、耐熱性で、混練可能な程度に低粘度である樹脂であれば熱可塑性樹脂であっても熱硬化性樹脂であっても特に制限はなく、例えばフェノール樹脂、フルフリルアルコール樹脂、エポキシ樹脂、尿素樹脂、メラミン樹脂等の樹脂を使用することができる。好ましくは、エポキシ樹脂であり、これはノボラック樹脂等の多価フェノール系硬化剤と共に使用される。なお、熱硬化性樹脂は硬化剤や硬化促進剤等を使用することがあるが、硬化した際、これらが熱硬化性樹脂と反応して樹脂の一部となることが多いので、原則として、これらも樹脂として計算する。
【００１３】また、黒鉛粉と熱硬化性樹脂等の樹脂の他に、上述した様な硬化剤、硬化促進剤や改質用添加剤及び他の導電性フィラー等を本発明の効果を妨げない範囲で配合することもできる。改質用添加剤としては、流動パラフィン等の液体、あるいは、カルナバワックス、低分子量ポリエチレンワックス、ステアリン酸亜鉛等の粉体状離型剤、酸化防止剤、可塑剤、その他の各種添加剤が挙げられる。また、界面活性剤や親水性樹脂等の親水性を補助する添加剤を本発明の効果を妨げない範囲で併用しても良い。さらに使用する樹脂に、ポリアミド、ポリエチレン、ポリプロピレン、ポリブチレンテレフタレート（PBT）、液晶ポリマー（LCP）等の熱可塑性樹脂を用いてもよい。
【００１４】黒鉛紛に熱硬化性樹脂を配合した組成物は、混練等により混合したのち、粉砕することが好ましく、粉砕物の平均粒径は５０μm以下、好ましくは２０～４０μmとすることが有利である。５０μm以上であると成形体の電気比抵抗が十分に低下せず、また粒径を小さくしすぎると粉砕費用が増大するだけでなく、逆に電気比抵抗が高くなる傾向がある。
【００１５】黒鉛紛と熱硬化性樹脂との配合物の成形法には格別の制限はないが、金型を使用する各種プレス成形法又は射出成形法が有利である。例えば、金型による加熱、加圧型の圧縮成形機や射出成形機などを使用して

成形する。この際、成形と同時に熱硬化性樹脂を硬化するために、１００～３５０℃、好ましくは１５０～２００℃程度に保持することにより行うことがよい。温度は使用する熱硬化性樹脂の硬化温度以上、炭化温度未満の条件とする。成形圧力は面方向の電気比抵抗を下げ、嵩密度を高くするためには高いほうが好ましいが、圧力を高くすると設備費用が増大するため、２０～１０００Kg/cm^2程度、好ましくは１００～８００Kg/cm^2程度、更に好ましくは２００～６００Kg/cm^2が適当である。

【００１６】本発明の燃料電池用セパレータ部材の本体は、ガス不透過性や機械的強度の点から、嵩密度が１．９０g/cm^3以上、好ましくは１．９５g/cm^3以上であることがよく、また、カーボンペーパーを含んだ面積抵抗（面圧０．５MPa）が４０mΩcm^2以下であることが好ましい。なお、面積抵抗は、後記する実施例に記載した測定法に従うものとする。更に、曲げ強度が３０MPa以上、気体透過率が１×１$0^{-14}$ｃm^2以下のいずれか１又は２以上の特性を有することが望ましい。

【００１７】本発明の燃料電池用セパレータ部材は、本体の外周部等の外表面部の少なくとも一部に強化用の枠材等の補強材（以下、両者を併せて枠材等ともいう）が取付けられて、本発明の燃料電池用セパレータ部材とされる。本体への枠材等の取付け方法は、本体を成形して取出し後、これに枠材等を取付ける方法などがあるが、離型時や加工時の割れを防止する目的からは、本発明の製造方法による方法が有利である。本発明の製造方法、黒鉛粉と樹脂を含有する材料と、セパレータ部材の外表面の少なくとも一部を覆う枠材等とを、一体成形すると共に熱硬化樹脂を硬化する方法である。上記のようにして成形、製造される燃料電池用セパレータ部材は、通常は板状体であり、ガス等を流す溝及び貫通孔が、成形時に又は成形後の加工時に、必要により所定数、所定位置に設けられる。

【００１８】

【発明の実施の形態】以下、本発明を、その一例を示す図面を参照して説明する。図１は、本発明の燃料電池用セパレータ部材の概略を示す平面図であり、図１の右側の図は枠材b配置部の拡大断面図である。所定の形状にされているセパレータ本体aの外周に、枠材bが取付けられて強化されている。枠材bはガス流路に関係ない外縁部のみに配置しているので、腐食問題や電気特性になんら影響を及ぼさずに燃料電池セパレータを強化でき、更に燃料電池用セパレータのそり防止効果を有する。また、枠材bは本体の外周部の全部に取付ける必要はなく、角部等の欠損しやすい部分のみに取付けてもよい。

【００１９】枠材等の材質は、燃料電池セパレータを補強できるのもであれば、特に制約されるものではないが、強度、剛性が高く、成形温度又は使用環境下においても強度、弾性率が低下しない材料が好ましい。引張強度は、割れを防止する観点からは、望ましくは３０MPa以上、より好ましくは５０MPa以上である。曲げ弾性率は、剛性を高め、変形しづらくして、割れを防止する観点からは、望ましくは３GPa以上、より好ましくは５GPa以上である。また、併せて耐食性を有する材料が好ましい。

【００２０】かかる観点からの枠材等の材質は、例えば、SUSやメッキ薄板、銅、チタン等の金属材料や木材が使用できる他、樹脂及びガラス繊維、カーボン繊維、セラミック等のフィラーで強化した樹脂材料を使用することができる。例えば、成形温度に対応した樹脂材料をフィラー、特に繊維で強化した樹脂材料が望ましい。特に、枠材の生産性を考慮すると金属材料や、木材、繊維強化樹脂等の材質が好ましい。また、これらの材料を組合せて使用してもよい。枠材等の材質として使用可能なないくつかの例を表１に示す。表１において、参考GF30％は、耐熱性が１８０℃未満と低く、成形温度又は使用温度に制約を生じる場合がある例であるが、成形温度又は使用温度が低い場合は使用可能である。

【００２１】

【表１】

繊維強化有無	樹脂名称	連続使用温度 ℃	引張強度 MPa	曲げ弾性率 GPa
なし	PTFE	260	34	-
	PEEK	230	91	3.9
	PAI	240	186	4.4
	PI	250	69	2.4
GF30%	LCP	250	157	12
	PEEK	230	173	10
	PEN	220	193	11
	PPS	200	151	10
参考 GF30%	PA66	100	177	8
	PBT	120	128	10
	PET	130	118	10
鉄		-	412	21
木材		-	曲げ54	7.8

【００２２】本発明で用いる枠材等の形状は、燃料電池セパレータ部材を補強できれば、特に限定されるものではなく、本体の外周部に勘合する形状の断面コの字型の形状に限らず、底面又は表面と側面を保護する断面Ｌ字型の形状のものや、本体外周部の側面のみに配置する帯状体であることもできる。更に、断面を三角形や台形等

のその他の形状としてもよく、端部をR加工、面取り加工してもよい。

【００２３】本体1への枠材の取付け構造と併せて、枠材の形状を図２に示す。図２において、ｂ1～ｂ6で表される斜線部が枠材を示しており、斜線部でない部分が本体を示している。ｂ１の態様の枠材は、本体の底面のみに配置した平面形枠材を示している。ｂ２の態様の枠材は、本体の側面である垂直面のみに配置した平面形枠材を示している。ｂ３の態様の枠材は、本体の底面の一部と側面である垂直面に配置した三角形枠材を示している。ｂ４の態様の枠材は、本体の底面の一部と側面である垂直面に配置したＬ形枠材を示している。ｂ５の態様の枠材は、本体の側面である垂直面の一部のみに配置した平面形枠材を示している。ｂ６の態様の枠材は、本体の底面と表面と側面である垂直面に配置したコ字形枠材を示している。

【００２４】枠材等は、例えば燃料電池セパレータが四角形の場合、４辺全てに配置したもの、強度的に問題がある個所のみに配置する場合、１辺のみや平行な２辺、隣り合わせた２辺、任意の３辺に配置するもの等がある。また、溝や穴の設計に合わせて枠材等の形状を変化させることもよい。強度的に問題があり、割れを生じ易い部位は、貫通孔が形成され、薄い厚みになった部分などが挙げられ、貫通孔の周辺や、薄い厚みになった部分の外表面にも枠材又は補強材を配置することができる。また、燃料電池セパレータ部材が、四角形以外の多角形や円、楕円の場合もこれに対応した任意の位置に配置すればよい。

【００２５】燃料電池セパレータ本体と枠材等との接着を強固にするために、枠材等の表面に凸凹を付ける、荒らす、貫通孔又は貫通しない孔を設ける等などが有効である。図３は、その態様示す説明図であり、斜線部が枠材を示し、斜線部でない部分が本体を示し、枠材にいくつかの貫通孔を設けた部分での断面説明図である。図３のｆ1は、本体の外縁底面の一部のみに枠材を配置した平面形枠材に貫通孔を設けた態様を示す例である。ｆ２は、周面である垂直面のみに枠材を配置した平面形枠材に貫通孔を設けた態様を示す例である。ｆ3は、本体の外縁底面の一部と周面である垂直面に配置した三角形枠材に貫通孔を設けた態様を示す例である。ｆ4は、本体の外縁底面の一部と周面である垂直面に配置したＬ字枠材に貫通孔を設けた態様を示す例である。ｆ5は、本体の周面である垂直面の一部のみに配置した平面形枠材に貫通孔を設けた態様を示す例である。ｆ6は、本体の周面である垂直面と底面及び表面の一部に配置したコ字形枠材に貫通孔を設けた態様を示す例である。そして、前記貫通孔には、本体形成材料が入り込み、一体化強度を高めている。更に、前記貫通孔の端面をRや面取り加工を行うと、枠材の外れ防止効果が増し有利である。

【００２６】上記のような孔を明ける場合は、その孔の形状は円、正方形、長方形、その他の多角形、楕円、長穴、星型等特に制約を受けるものではない。孔の大きさや配置、数は、燃料電池セパレータや枠材の寸法及び穴形状に合わせて設計すればよく、特に制約を受けるものではない。また、枠材の表面に凸凹を付ける、荒らす、枠材に貫通孔若しくは非貫通孔を設ける等、これらを組合せて実施してもよい。コ字形の枠材を使用する場合は、上面に貫通孔を設けることが望ましい。枠材の表面に凸凹を付ける方法や荒らす方法穴を明ける方法は、金属や樹脂、木材等で適正な方法があるので、機械加工、成型加工、化学的方法等特に制約は無く材料に適した方法を取ればよい。

【００２７】枠材等はガス流路に関係ない外周部又は外縁部のみに配置することがよく、その場合、腐食問題や電気特性になんら影響を及ぼさずに燃料電池セパレータを強化でき、更に燃料電池用セパレータのそり防止効果をも有する。

【００２８】

【実施例】以下に具体的な実施例を挙げて本発明を更に詳細に説明するが、本発明はこれらの実施例に何ら限定されるものではない。実施例等におけるセパレータ部材の評価方法等は次の通りである。

【００２９】（１）枠材による補強効果

図４に示す燃料電池セパレータセパレータ金型を使用して成形し、離型時の割れ有無により効果を判定した。図４は離型時に割れが発生しやすい形状の燃料電池セパレータ金型の平面図であり、c1, c2, c3, c4は貫通長孔を形成する突起部であり、d1, d2, d3, d4は貫通小孔を形成する突起部であり、eはサーペンタイン溝を形成する突起部である。

【００３０】（２）面積抵抗（$m\Omega cm^2$）

図５は面積抵抗の測定方法を説明するための概念図であり、厚さ３㎜の試料（セパレータ部材）１の上下にカーボンペーパー２を配置し、更にその上下に銅板３を配置し、上下方向に面圧０．５MPaの圧力をかける。２枚のカーボンペーパー２間の電圧を電圧計４で読むと同時に、２枚の銅板３間の電流を電流計５で読んで抵抗（平均値）を計算する。なお、使用したカーボンペーパーは、東レ社製のＴＧＰ－Ｈ－Ｍシリーズ（０９０Ｍ：厚さ０．２８㎜、１２０Ｍ：厚さ０．３８㎜）である。

（３）そり測定

当燃料電池セパレータを定盤上に置き、上面よりレーザー変位計にてレーザー変位計から燃料電池セパレータの各測定点（１７箇所）までの距離を測定し、距離の最大値と最小値の差を算出して、そり量とする測定を行った。

【００３１】実施例１

平均粒径１１０μｍのCIP成形で得られた等方性人造黒鉛粉５０重量部と平均粒径１０μｍのキッシュ黒鉛粉５０重量部を混合した黒鉛粉合計１００重量部に、エポキ

シ樹脂、硬化剤及び硬化促進剤からなる熱硬化性樹脂類を黒鉛粉量/熱硬化性樹脂量＝９（重量比）で配合した。ここで、熱硬化性樹脂類は、エポキシ樹脂としてテトラメチルビスフェノールF型エポキシ樹脂（新日鐵化学株式会社製、商品名YSLV-80XY）２重量部、硬化剤としてフェノールノボラック（荒川化学工業社製タマノル７５８）１重量部及び硬化促進剤としてトリフェニルホスフィン（北興化学工業社製）０．０３重量部の割合で配合したものである。これを、１００℃に加熱したロールで混練した。得られた混練物を粉砕機で微粉砕した。１２０×１２０×１．９mmサイズの前記金型に、幅２mm高さ１．９mmのSUS製枠材を金型内周壁にインサートし、前記粉砕物を入れ、温度１７５℃、圧力３５０kg/cm^{2}の条件で２０分間成形し、外周側面の全周に枠材を有する構造の成形品とし、離型した。得られた成形品の割れ状況及び物性値を表２に示す。

【００３２】実施例２

実施例１と同様な実験において、枠材として木材製の枠材を使用した以外は、実施例１と同様の方法で成形を行った。得られた成形品の割れ状況及び物性値を表２に示す。

【００３３】比較例１

実施例１と同様な実験において、枠材を使用しなかった以外は、実施例１と同様の方法で成形を行った。得られた成形品の割れ状況及び物性値を表２に示す。実施例１、２では、割れを生じなかったが、枠材を取付けていない比較例１では、排水孔として形成された貫通孔の近傍で薄くなった部位に割れを生じてしまった。また、そり量も、実施例に比べて、倍以上となった。

【００３４】

【表２】

項目	実施例１	実施例２	比較例１
割れ状況	割れなし	割れなし	割れ発生
面積抵抗 mΩcm^2	１５．１	１５．２	１５
そり量 μm	４０	５０	１２０

【００３５】

【発明の効果】本発明によれば、燃料電池セパレータの外周部等の損傷しやすい部位を枠材で強化することで、性能に影響を及ぼさずに、割れやそり等の問題を回避できるので、セパレータ形状の設計に制約が少なくなり、燃料電池の性能アップに寄与でき、燃料電池用のセパレータとしての価値が高い。

【図面の簡単な説明】

【図１】　燃料電池セパレータの概略模式図

【図２】　枠材部周辺の断面図

【図３】　枠材部周辺の他の断面図

【図４】　燃料電池セパレータ金型の平面図

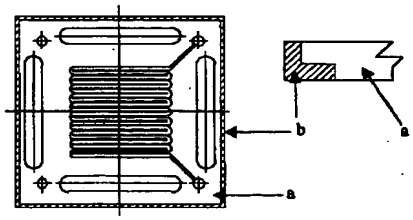
【図５】　面積抵抗の測定方法を説明するための概念図

【符号の説明】

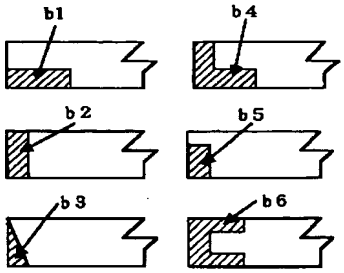
a:燃料電池セパレータ本体

b:枠材

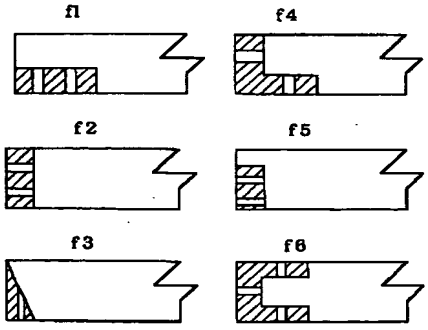
【図１】



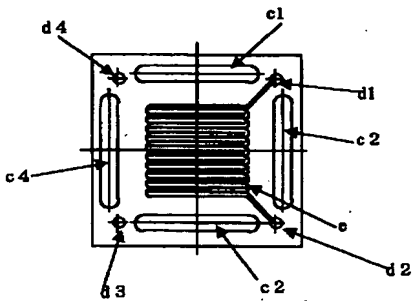
【図２】



【図３】



【図４】



【図５】